Measuring Atmospheric Pressure

Barometers and Isobars

Donald W. Hillger and Garry Toth

As a follow-up to our article on *Thermometers on Stamps* we decided to write a similar article on another meteorological instrument, barometers on postage stamps. Although only a limited number of stamps show barometers, there are many more stamps that show pressure measurements as plotted on weather maps. These pressure measurements are normally represented as lines of constant pressure, or isobars.

The barometer is a widely-used device for measuring atmospheric pressure, one of the primary measurements in everyday weather observations and reports. The barometer was a long time in development because the concept of the air having weight was not easy to understand.

Atmospheric pressure can be measured in numerous ways. The most basic barometer is a well-type liquid-column gauge. The pressure of the air against the open surface of liquid (usually mercury) in the well supports the liquid-filled column of mercury as it tries to empty into the well. As the mercury flows out of the column, it creates a vacuum at the top of the sealed column. The length of the mercury column is a measure of absolute atmospheric pressure (relative to vacuum). Barometers can also be made using metallic diaphragm elements. Atmospheric pressure is measured relative to the pressure in the low-pressure diaphragm, but the measurements can be calibrated to give absolute atmospheric pressures.

With the invention of calibrated barometers, pressure began to be measured quantitatively rather than just qualitatively. Barometers can be calibrated in different pressure scales. For the mercury barometer the pressure is measured indirectly as the length of the column of mercury extending above the well. Usually the length is calibrated in either inches (in the United States) or in millimeters (throughout the rest of the world). The standard air pressure at the surface of the earth is called one atmosphere, which is also equal to 760 millimeters (approximately 29.92 inches) of mercury. Neither of these are physical pressure units, only lengths which are related to atmospheric pressure.

The most widely used pressure unit throughout the meterological world is the millibar (mb), or 1000th of a bar. A bar (1000 mb) is a metric unit close to the standard pressure of air at the earth's surface. Most countries use this as the primary pressure scale for drawing weather maps. With the standardization of metric units into the International System of Units (SI), the hectopascal (hPa), equal to 100 pascals, is replacing the millibar. Because the pascal is a much smaller unit than the millibar, the choice of the hecto prefix results in a pressure that is identical in size to the millibar. The hectopascal avoids the need for a change in the numbers normally plotted on weather maps, whereas the kilopascal (kPa) is more commonly used for pressures in other disciplines.

Pocket Aneroid Barometer
Australian Antarctica (*Scott* L58)

The stamps for this article are placed into two main groups. The first group of stamps picture barometers or barographs (recording barometers) used for weather observations. A second group of stamps show pressure measurements plotted on weather maps for the analysis of current weather and the forecasting of future weather. Many of these stamps feature isobars or constant pressure lines that are the basis for weather maps generated from observations taken at regular intervals throughout the most of the world.

Barometers and Barographs

Many stamps show symbolic aneroid barometers, but only two stamps are known to show detailed likenesses of real barometers. The first stamp from Australian Antarctic

Wall Barometer With Word Scale
Hungary (*Scott* 3490)

Graduated Scale On Barometer
Tunisia (*Scott* 441)

Territory (*Scott* L58) was issued in 1984 for the 75th anniversary of the South Pole Magnetic Expedition that took place in 1909. The stamp shows two important instruments used during the expedition, a pocket-type aneroid barometer, and a theodolite for determining latitude. The barometer scale is detailed enough to be readable with a pressure scale in inches and an altitude scale in feet.

The other good representation of an aneroid barometer is on a Hungarian stamp (*Scott* 3490) issued in 1995 for the 125th anniversary of the Hungarian National Meteorological Service. This wall-type barometer has a detailed scale but the units are not clear. Some barometers of this type also have a relative scale in words indicating the type of weather generally associated with certain pressures: fair weather for high atmospheric pressure, and stormy weather for low pressure. Of course, in this case, the words are in Hungarian.

Tunisia has issued two stamps that show aneroid barometers. The first one (*Scott* 441) issued in 1964 for the 4th World Meteorological Day[1] (hereafter designated only by the acronym WMD) shows the right half of an aneroid barometer face with a graduated scale and dial but no numbers. The second stamp (*Scott* 621) issued in 1973 for the centenary of International Meteorological Organization (IMO), a predecessor to the World Meteorological Organization (WMO), shows an aneroid barometer with no numbers

Barograph Records Pressure Readings
Chad (*Scott* 100)

Left Hand Face Of A Barometer
Algeria (*Scott* 351)

but with relative weather indicators of the fair-to-stormy variety but in French. An Algerian stamp (*Scott* 351) issued in 1966 for the 6th WMD contains an aneroid barometer as well; this time the left half of a barometer face has a graduated scale and dial but no numbers or relative indicators.

The next three stamps show both an aneroid barometer and a recording barograph. All three stamps, from the former French colonies of Chad (*Scott* 100), Congo (*Scott* 111), and Gabon (*Scott* 170), have a common design and were issued in 1964 for the 4th WMD. The larger device on each stamp is a barograph that records pressure readings by up and down movements of a pen on a slowly rotating drum. The pen moves because of atmospheric pressure changes on a low-pressure diaphragm similar to that used in dial-faced aneroid barometers. The paper on the rotating drum is typically changed after several days and these charts are saved as weather records. These three stamps also show an aneroid barometer. The spring mechanism can be seen in the center of the face. The dial points to a graduated scale but no numbers are indicated.

Barographs are also a major feature on a set of four nearly-identical stamps of different color and denominations from South Vietnam (*Scott* 235-238) issued in 1964 for the 4th WMD. In 1962 New Caledonia issued a stamp (*Scott* 322) for the 3rd Regional Assembly of the WMO. It shows air currents as long arrows blowing from the north.

A stamp from Upper Volta (*Scott* 130) issued in 1964 for the 4th WMD shows a device that is described by *Scott* as a barograph. Even though it looks similar to a barograph, it is a recording rain gauge. The indicators are the funnel mechanism for catching rain, a small tipping-bucket device to alternately store and dump the rainwater, and an ever-ascending trace on the paper chart that indicates accumulated rainfall. Another stamp from Upper Volta (*Scott* C21) issued in 1965 for the 5th WMD shows an image of the earth and a smaller composite image of half of the sun, a map of Africa, and an aneroid barometer face with a dial but no numbers.

Most Detailed Barograph on a Stamp
Uganda (*Scott* 1200)

Torricelli Invented Barometer
San Marino (*Scott* 1043)

Another postal item shows a barometer as well as a thermometer and a thermograph and was mentioned in our thermometer article. This souvenir sheet from Uganda (*Scott* 1200) shows in the center the most detailed barograph on a stamp, the type of instrument commonly used for recording of atmospheric pressure changes over the period of a week.

The last two stamps showing barometers contain early versions of the instrument. A stamp issued by the Netherlands (*Scott* B621) in 1986 shows an early version of the aneroid barometer, and a stamp issued by San Marino (*Scott* 1043) in 1983 is the only stamp known to show a mercury-column barometer. The barometer is the small device in the upper-left corner. The stamp also shows a portrait of Evangelista Torricelli, the person normally credited with inventing the barometer.

A barograph trace is shown on the left side of a stamp issued in 1964 by Morocco (*Scott* 103) for the 4th WMD. This trace accurately shows pressure changes associated with both small-scale perturbations in the weather and larger-scale changes due to the passage of weather fronts. Finally, images of barometers are not limited to stamps. A cachet on a cover issued by Brazil for the 4th WMD shows a recording barograph.

Isobars

Numerous stamps show isobars or constant pressure lines that are the basis of most plotted weather maps. Weather maps were drawn by hand until computers were able to interpolate the pressure lines. Isobars are derived from pressure readings taken at weather stations at regular and synchronized intervals so that weather maps can be created.

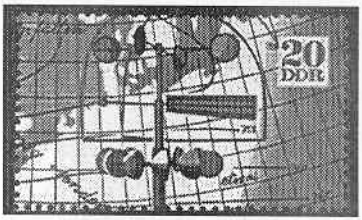
Early Type of Aneroid Barometer
Netherlands (*Scott* B621)

For upper-air weather, balloon-borne sounding instruments collect the pressure, temperature, and humidity readings. For surface weather, the reports come from automated weather instruments, which were formerly obtained from human-read instruments. In either case, the surface weather information is displayed in a special format known as a surface plotting model. This way of displaying weather measurements has been standardized throughout the world so that meteorologists can share and understand weather information from anywhere.

A stamp showing a very clear surface plotting model was issued by Canada in 1990 (*Scott* 1287) for the 150th anniversary of weather observations. This beautiful stamp shows a cumulus cloud background and a rainbow. Numerous details of the surface plotting model have been covered in an article specifically about this stamp in *Nature's Wonders*.

Because there are numerous stamps that display isobars, it was decided to mention only those stamps detailed enough to discern the pressure units.

As mentioned previously, isobars are plotted in standard units of millibars or hectopascals. However, until that standard was adopted other units were sometimes used. Evidence of this is available on a souvenir sheet (*Scott* 1362) issued in 1972 by the German Democratic Republic for an International Meteorological Centenary Meeting in Leipzig. The stamp shows an anemometer for measuring wind speed and direction, but the features of interest are the isobars plotted on the background map, a map which is supposed to represent the first German weather chart. The pressures are plotted in units of millimeters of mercury. The lower values around 760 are equivalent to values near 1000 when plotted in millibars.



First German Weather Chart
German Democratic Republic (*Scott* 1362)

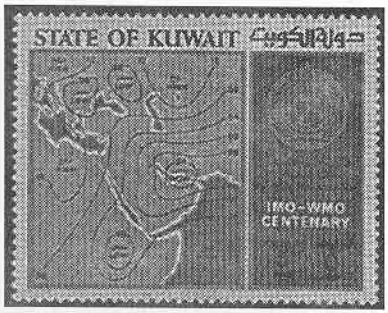
Another souvenir sheet (*Scott* 1364) in the same 1972 set from the German Democratic Republic shows a Russian Meteor weather satellite over a background weather map. This time the pressures are plotted in millibars with detailed information on a low pressure center and the cold and warm fronts associated with that low.

Germany has issued three stamps showing isobars with the units discernable. The first stamp (*Scott* 1102) issued in 1973 for the IMO-WMO centenary shows a detailed weather map with isobars labeled in millibars. Also shown are high and low pressures and weather fronts. The second stamp (*Scott* 1404) was issued in 1983 for a General Assembly of the International Union of Geodesy and Geophysics (IUGG) held in Hamburg. One of the panels on the stamp contains a weather map with isobars labeled in units of millibars. The third stamp (*Scott* 2090) was issued in 2000 for the centenary of the weather station on Zugspitze, a prominent mountain on the border between Germany and Austria. The lower-left corner of the stamp contains a small weather map with some of the meteorological data in the surface plotting model form.

Some of the most detailed weather maps are shown on a set of three stamps (*Scott* 577-579) issued in 1973 by Kuwait for the IMO-WMO centenary. An interesting point about the isobars on these stamps is the display of only the last two digits of a three or four digit value in millibars.

A Japan stamp (*Scott* 1564) issued in 1984 for the centenary of weather forecasting

Isobars and Weather Fronts Shown
Germany (*Scott* 1102)



Displays Limited Millibar Values
Kuwait (*Scott* 577)

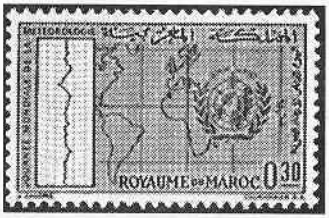
shows a Geosynchronous Meteorological Satellite (GMS) over a weather map of Japan. The isobars are clearly labeled in millibars using all four digits. A similar style is used on a stamp (*Scott* C78) issued in 1976 for the 40th anniversary of the Mongolian meteorological service. The stamp shows a Russian weather satellite over a map of Mongolia, and the isobars are clearly labeled in millibars.

In 1964 Morocco issued a stamp (*Scott* 102) for the 4th WMD. The weather map over Africa consists only of isobars with no weather fronts, features that are less common in the tropical regions than at higher latitudes.

Of the final two stamps showing isobars with units, the first one (*Scott* 1114) issued in 1971 for the 25th anniversary of the Portuguese meteorological service shows an instrumented weather balloon over a weather map. With a magnifying glass the details of the weather map can be seen, including some weather data plotted in the surface plotting model form; however not all of the weather elements in the plotting model are present. Also, it can be seen that the isobars are labeled in millibars.

The other stamp from Upper Volta (*Scott* C28) issued in 1966 for the 6th WMD shows a Television and Infrared Observation Satellite (TIROS) over an isobar pattern typical of a low pressure center. The details can be

Clearly Labeled in Millibars
Mongolia (*Scott* C78)



Tracings Record Pressure Changes
Morocco (Scott 103)

seen with a magnifying glass, including a cold front and isobars labeled in millibars.

Finally, an aerogramme issued in 1999 to commemorate activities of the Spanish National Meteorological Institute shows isobars labeled in millibars in the cachet portion of this postal item.

There are many more stamps that show isobars with varying degrees of detail, but this article does not cover those stamps. Rather, it was decided to feature only those stamps showing weather maps with isobars detailed enough to contain discernable pressure units. For interested readers, the authors can supply a list of additional stamps showing isobars without units.

All of the postage stamps mentioned in this article are related to the topic of weather or meteorology. If readers know of other stamps showing barometers or isobars the authors would appreciate hearing about them.•

Bibliography

Frisinger, H.H., 1977: *The History of Meteorology to 1800*, American Meteorological Society, ISBN 0-88202-036-6. [Chapter 5: The Barometer, p. 67-79.]

Hillger, D.W., and G. Toth, "2000: Thermometers on Stamps," *Topical Time*, vol. 51(4), July-August, p. 24-28.

Middleton, W.E.K., 1964: *The History of the Barometer*, Johns Hopkins Press, Baltimore, LC 64-10942, 489 p.

A Rain Gauge, Not a Barograph
Upper Volta (*Scott* 130)

Weather Balloon Over Isobar Map
Portugal (*Scott* 1114)

Toth, G., 1999: "Weather Maps and the Plotting Model for Surface Observations," *Nature's Wonders*, whole no. 85, v. 22(2), June, p. 20-21.

World Meteorological Day has been celebrated on March 23 every year since 1961 when the first WMD was established.

Donald W. Hillger, Ph.D., is a research meteorologist with the National Oceanic and Atmospheric Administration (NOAA) and holds a cooperative position at Colorado State University. His topical interests include weather stamps, unmanned satellites on stamps, satellite launch covers, and metric and standards stamps. Send correspondence to: 309 North Shores Circle, Windsor, CO 80550-2614; or e-mail: hillger@cira.colostate.edu

Garry Toth, M.Sc., is an operational meteorologist with Environment Canada at the Canadian Meteorological Centre in Montréal. He is interested in all aspects of weather and climate on stamps. Send correspondence to: 106 Caruso, Dollard des Ormeaux, Québec, Canada, H9A 1L9; or e-mail: garry.toth@ec.gc.ca

★★★★★